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I, KIM MARSHALL, MANAGER PATENT OPERATIONS, hereby certify that the annexed is a true copy of the Provisional specification in connection with Application No. PP 7740 for a patent by FIRST GREEN PARK PTY LTD. filed on 16 December 1998.

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ORIGINAL

PROVISIONAL SPECIFICATION

PRE-STRETCHED SILAGE FILM

The invention is described in the following statement:

PRE-STRETCHED SILAGE FILM

The present invention relates to improved methods of wrapping hay bales with plastics material film to produce silage or any other comparable application where it is desired to minimise the flow of oxygen to the wrapped product. While this invention will be described with reference to the production of silage, it will be appreciated that it has application in other fields.

Traditionally silage was and sometimes still is produced by locating wilted cut grass within a pit for a period of time. More recently silage has been produced by wrapping wilted cut grass in an envelope of plastics material film, typically the cut grass being formed into a round bale and then wrapped in at least two layers of plastics material film. The film conventionally used for this purpose is relatively thick (of the order of 25 microns) and is stretched under tension as it is applied to the bale to wrap the bale tightly. Typically the wrapping tension is achieved by stretching the film at the point of application to the bale by 55-75%, however, this application stretch will often relax to some extent (although not totally) after application. It is well recognised that for good silage production, it is necessary to substantially restrict or prevent as far as possible, the flow of oxygen to the cut grass wrapped in the plastic film. It is therefore conventional wisdom in the industry to wrap the bale in relatively thick film as it is believed this will restrict oxygen transmission through the plastics material film. Moreover, the film is normally applied with reasonably high tension to attempt to exclude or force air out of the bale as much as possible. In recent years in industrial or packaging applications where the creation of anaerobic conditions within the package is of no importance, it has been recognised that less plastics material film in volume can be used if the film is produced with reduced thickness levels and typically with thickness levels that cannot be reliably produced by conventional extrusion techniques. These films are produced by stretching techniques beyond the yield point of the plastics material film such that the film length is substantially increased and its thickness is reduced. Examples of such stretched films and methods of producing same may be found in Australian Patent Specification No. 643902 and German Specification No. P 3409117. It has not been thought to use such stretched

plastics material film for wrapping silage making material because of the perceived likelihood that there would be an unacceptably high increase in the flow rate of oxygen through such thinned plastics material film. Moreover, it has been recognised that increased oxygen levels within the pores of the plastics material film adversely affects degradation of the film by ultraviolet light. Traditionally, it was felt that thinner films with increased oxygen levels within the film would degrade more quickly and therefore be considered unsuitable for silage production uses.

The objective of the present invention is to provide both a pre-stretched plastics material film and a method of wrapping material with pre-stretched plastics material film that will enable an anaerobic atmosphere to be created within the wrapping envelope. A preferred objective of the invention is to provide a method of wrapping material with pre-stretched plastics material to produce silage and of course a method of producing silage thereby.

Accordingly, the present invention provides a method of wrapping a material, object or objects, to create an anaerobic atmosphere within a wrapping envelope, said method including providing an at least partially relaxed plastics material film pre-stretched beyond its yield point to increase its length and decrease its thickness, applying said pre-stretched plastics material film to be wrapped in at least one layer with at least sufficient applied further tension to form said wrapping envelope with an anaerobic atmosphere therewithin.

According to a further aspect, the present invention provides a method of wrapping a material, object or objects to create an anaerobic atmosphere within a wrapping envelope, said method including providing a plastics material film and stretching said film beyond its yield point to decrease the thickness and increase the length of the film, at least partially relaxing said stretched plastics material film, applying said partially or fully relaxed stretched plastics material film to be wrapped in at least one layer with at least sufficient applied further tension to form said wrapping envelope with an anaerobic atmosphere therewithin. Preferably the stretched plastics material film is substantially fully relaxed before being utilised to form said wrapping envelope.

In accordance with yet a further aspect of the present invention, a plastics material film is provided, said film being first stretched beyond its yield point to increase its length and decrease its thickness, said film being at least partially relaxed. If desired, the film may be stretched again after the at least partial relaxation of the film. The second or further stretch may be to an extent less than the initial stretch or, if desired, go beyond this initial stretch.

It has been surprisingly found that by relaxing or partially relaxing the pre-stretched plastics material film that has been stretched beyond its yield point and utilising this film to form a wrapping envelope, a significantly increased resistance to gas (oxygen) transmissivity is achieved per unit thickness of the film. In other words, if the film thickness is decreased by half in the pre-stretching process and relaxing, the gas transmissivity level (cc/m^2/day) is not increased to twice its original level as might be expected but is significantly lower than this. Moreover, it has been surprisingly found that putting the plastics material film through a second stretching process, does not significantly adversely affect gas transmissivity level of the film, at least to an extent that would prevent its use in forming an anaerobic envelope. It will of course be apparent that the material to be wrapped may be a silage producing material such as cut wilted grass or may be any other product, group of products or material that might benefit from an anaerobic atmosphere.

The term "anaerobic atmosphere" used above and hereinafter is intended to identify an atmosphere that has minimal oxygen gas therein or flowing thereto to the extent sufficient for the material within the wrapped envelope to benefit satisfactorily therefrom. The terms "relaxed" or "relaxing" when referring to pre-stretched plastics material film is intended to mean that the film is relaxed as much as possible after the film has been stretched (or pre-stretched). The film may, however, contain some residual memory that in the absence of any restraining forces would cause the film to slowly contract in length over time. The terminology "secondary stretch" or "secondary stretching" used above and hereinafter refers to that percentage of elongation applied to the film after stretching and relaxing or partially relaxing.

According to a still further aspect, the present invention provides a method of making silage, forming a wrapping envelope about said bale utilising an at least partially relaxed plastics material film pre-stretched before relaxation beyond its yield point to increase its length and decrease its thickness, applying said pre-stretched plastics material film to be wrapped in at least one layer to form said wrapping envelope with an anaerobic atmosphere therewithin.

According to yet another aspect, the present invention provides a method of making silage including providing a bale of silage making material, and forming a wrapping envelope about said bale having at least one layer of a pre-stretched plastics material film that has been stretched beyond its yield point to form a film with reduced thickness and increased length, at least partially relaxing said film, and applying said pre-stretched plastics material film to said bale with at least sufficient tension to form said wrapping envelope with an anaerobic atmosphere therewithin.

In accordance with yet another aspect, the present invention provides a method of making silage including providing a bale of silage making material, forming a wrapping envelope about said bale utilising a plastics material film that has been first stretched beyond its yield point to increase its length and decrease its thickness and thereafter at least partially relaxed, said plastics material film undergoing a secondary stretch after being at least partially relaxed, applying said plastics material film to be wrapped in at least one layer about said bale to form said wrapping envelope with an anaerobic atmosphere therewithin.

Preferably the aforesaid secondary stretch occurs prior to the film being applied to said bale. Alternatively, the secondary stretch may occur as the film is applied to the bale. Conveniently the secondary stretch may be either lower than or beyond the initial or pre-stretch level.

Preferably the film is substantially completely relaxed prior to said film being applied to said bale. Conveniently the envelope is formed by at least two or three or more layers.

Conveniently, the plastics material film is a linear low density polyethylene stretch film, preferably an octane, butene or hexthene. Preferably

the film has been pre-stretched or is first stretched beyond its yield point to an extent sufficient to increase its length by at least 75% and preferably by at least 100%. Preferably the film if the film is initially about 25 microns thick, after the first stretch or pre-stretching it has a thickness of between 10 and 15 microns.

It is believed that the present invention will also apply to any plastics material film that is pre-stretched and at least partially relaxed, or pre-stretched, at least partially relaxed, and then undergoes a secondary stretch either below the pre-stretch level or beyond it, with the film, in either case, thereafter being annealed, i.e. heating and immediately quenching (cooling) the film so that contraction of the film is prevented.

The present invention will hereinafter be described with reference to the accompanying drawings and examples set out in the following. In the annexed drawings :-

Figure 1 is a schematic diagram of a method of producing pre-stretched plastics material film for use in the present invention; and

Figures 2 to 4 illustrate one possible form of machinery for forming a wrapping envelope according to the present invention in the process of forming silage.

Figure 1 illustrates a method of producing pre-stretched plastics material film wherein an extruder 10 operates in a known manner to generally inflate a film bubble 11 which is drawn up from the extruder 10 passing through primary nip rollers 12 to collapse the bubble. From the primary nip rollers 12 the plastics material film 13 is passed via idler rollers 14, via a film trimming and/or splitting station 15, to secondary nip rollers 16 to be wound upon film winding rollers 17.

The plastics material film 13 may undergo a stretch process by following the path 13' shown in dashed outline via an in-line stretching unit 18 shown from A to AA. Alternatively, stretching of the film may occur as a separate process by taking a roll of film 23 produced as shown in Figure 1 and passing same through a stretching unit 18 as shown from A to AAA of Figure 1 omitting of course the splitting unit 15. In either case the stretching unit 18 includes a low speed roller 19 and a high speed roller 20 with stretching of the film 13' occurring generally between these two rollers. The secondary nip rollers 16 are

driven at a speed similar to the high speed roller 20 with substantially complete relaxation (to the extent possible) of at least the elastic deformability of the film occurring between the secondary nip rollers 16 and the wind up roller 17. Each of the rollers 19, 20 has an associated idler nip roller 22 and there may be provided between the rollers 19, 22 and 20, 22, a film width adjustment roller 21.

The above described arrangement permits, by adjusting the relative speeds of the rollers 19 and 20, a stretching of the plastics material film beyond its yield point to simultaneously lengthen the film and reduce its thickness. By appropriately adjusting the speeds of the rollers, it is possible to vary the stretching of the film beyond its yield point to achieve desired film lengthening and film thickness reductions. For example, a plastics material film that is stretched to twice its length will have approximately half its original thickness.

In the following example, a plastics material film initially at 21 microns thickness was stretched beyond its yield point to effectively reduce its thickness by half, that is 10.5 microns. The plastics material film was tested prior to stretching and after stretching to determine its capability of resisting oxygen transmission. Each film, i.e. the 21 micron non-stretched film and the 10.5 micron pre-stretched film (after initially relaxing) was then stretched a further 10% within the retained elasticity of the film in each case to simulate the application of each sample to a bale for the purpose of making silage under a small tension force. The oxygen transmissivity of the film in each case was further tested and the results obtained are set out in the following table.

Sample (low density polyethylene plastics material film)	Film Thickness (microns)	Oxygen transmissivity (cc/m2/day) (no further stretching)	Oxygen transmissivity (cc/m2/day) (after elastic stretching of 10%)
A (not stretched)	21	14,000	21,600
B (sample A pre-stretched beyond its yield point)	10.5	17,400	18,700

It will be apparent from the foregoing figures that by pre-stretching the film to approximately half its thickness, there surprisingly results only a 24.3% increase in the oxygen transferred through the film compared to the doubling that might have been expected by the halving of the film thickness. Even more surprising is that if the 10.5 micron film is stretched again by a further 10%, the percentage increase in oxygen transmissivity is only 7.5% compared to 54% for the 21 micron film if it is stretched by a similar 10% and in fact the resistance to oxygen, transferral through the 10.5 micron film is actually better at this point than it is for the 21 micron film that has not been pre-stretched.

In another example linear low density polyethylene film of initially generally 24 microns thick (samples A/B) was stretched to the degree that would normally occur when applying same to a bale during forming a silage making envelope. Sample C has a 55% stretch level and sample D has a 70% stretch level simulating the usual degrees of stretch when applying normal silage making film to a bale. Samples C and D are essentially the film of A/B stretched as aforesaid. Samples E/F are the film of A/B that has been pre-stretched to beyond its yield point, the stretch being by 150% to increase its length and decrease its thickness. That is to say if the film was 100 m long initially, after the pre-stretch it would be 250 m long. The samples of E/F, after the pre-stretch stage have been relaxed by about 18% of the total, stretched length. Finally the samples G/H are the film of samples E/F that has undergone a secondary or further stretch of 33% of the relaxed state. The following table lists the samples, the approximate thickness of each sample and the tested oxygen transmissivity (cc/m^2/day).

Sample	Thickness (Microns)	Oxygen Transmissivity
A	24	12170
B	24	10900
C	18	18600
D	17	21300
E	13	14550
F	13	12600
G	12	13660
H	12	13370

It will be apparent from the foregoing that samples E to H are approximately half the thickness of samples A and B and their oxygen transmissivity is not significantly greater than for samples A and B. More particularly, however, the samples G and H show that placing the pre-stretched plastics film through a secondary stretch to a level even greater than the pre-stretch level, also does not significantly affect the oxygen transmissivity levels.

Referring now to Figures 2 to 4, there is illustrated one possible means of applying pre-stretched plastics material film 13' to a bale for producing silage. A similar process may be used for any other material, product, or combination of products where the current process would prove useful.

In this arrangement the bale 24 is supported on rollers 25, 26 carried by a rotatable frame 27. The rollers 25, 26 are driven to rotate the bale 24 about its axis as indicated by arrows 28. At the same time, the frame 27 and the bale 24 carried thereby is rotated as indicated by arrows 29. As is shown best in Figure 4, film 13' is led from a roll 30 of such film rotatably supported on a frame 31 to be sequentially applied in overlapping sections to the bale 24 as shown in Figure 4. Typically the bale 24 would be covered in at least two and sometimes three layers of such film to form a wrapping envelope. Figures 2 and 3 illustrate one mechanism 32 for outfeeding of the film from the roll 30. In this example, the mechanism 32 includes a pair of rollers 33, 34 mounted on a swinging arm 35 urged in a direction such that the first roller 33 engages and is driven by rotation of the roll of film 30. The film 13' itself is led from the roll 30 around the second roller 34 to the bale 24. The roller 34 is driven at a speed in direct relationship to the speed of the first roller 33 by a pair of sprocket wheels 36, 37 and a sprocket chain 38. The size of the sprocket wheels 36, 37 is approximately equal so that no tension is imparted to the film 13' by the rollers 33, 34 rotating at different speeds. It may, however, be desirable to impart a small tension to the film 13' at this point and in consequence the roller 34 may be arranged to rotate at a speed sufficient to impart up to 30% elongation in the film at this point, preferably of the order of 10% elongation.

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of wrapping a material, object or objects to create an anaerobic atmosphere within a wrapping envelope, said method including providing a plastics material film and stretching said film beyond its yield point to decrease the thickness and increase the length of the film, at least partially relaxing said stretched plastics material film, applying said relaxed stretched plastics material film to be wrapped in at least one layer with at least sufficient applied further tension to form said wrapping envelope with an anaerobic atmosphere therewithin.

2. A method of wrapping a material, object or objects, to create an anaerobic atmosphere within a wrapping envelope, said method including providing an at least partially relaxed plastics material film pre-stretched beyond its yield point to increase its length and decrease its thickness, applying said pre-stretched plastics material film to be wrapped in at least one layer with at least sufficient applied further tension to form said wrapping envelope with an anaerobic atmosphere therewithin.

3. A method according to Claim 1 or Claim 2, wherein the object is a bale of silage making material.

4. A method of making silage, including providing a bale of silage making material, forming a wrapping envelope about said bale utilising an at least partially relaxed plastics material film pre-stretched before relaxation beyond its yield point to increase its length and decrease its thickness, applying said pre-stretched plastics material film to be wrapped in at least one layer to form said wrapping envelope with an anaerobic atmosphere therewithin.

5. A method of making silage including providing a bale of silage making material, and forming a wrapping envelope about said bale having at least one layer of a pre-stretched plastics material film that has been stretched beyond its yield point to form a film with reduced thickness and increased length, at least partially relaxing said film, and applying said pre-stretched plastics material film to said bale with at least sufficient tension to form said wrapping envelope with an anaerobic atmosphere therewithin.

6. A method of making silage including providing a bale of silage making material, forming a wrapping envelope about said bale utilising a plastics material film that has been first stretched beyond its yield point to increase its length and decrease its thickness and thereafter at least partially relaxed, said plastics material film undergoing a secondary stretch after being at least partially relaxed, applying said plastics material film to be wrapped in at least one layer about said bale to form said wrapping envelope with an anaerobic atmosphere therewithin.

7. A method according to Claim 6, wherein said secondary stretch occurs prior to the film being applied to said bale.

8. A method according to Claim 6, wherein said secondary stretch occurs as the film is applied to said bale.

9. A method according to any one of Claims 6 to 8, wherein the secondary stretch is beyond the level of said first stretch.

10. A method according to any one of Claims 6 to 8, wherein the secondary stretch is less than the level of said first stretch.

11. A method according to any one of Claims 1 to 10, wherein in the said relaxing stage the film is substantially completely relaxed.

12. A plastics material film used in any one of the methods according to Claims 1 to 11.

13. A plastics material film for forming an anaerobic wrapping envelope that has first been stretched beyond its yield point to increase its length and reduce its thickness, said film being at least partially relaxed.

14. An anaerobic wrapping envelope including at least one layer of overlapping plastics material film stretched beyond its yield point to increase its length and reduce its thickness, said film being at least partially relaxed before being configured to form said anaerobic wrapping envelope.

DATED THIS 15TH DAY OF DECEMBER, 1998

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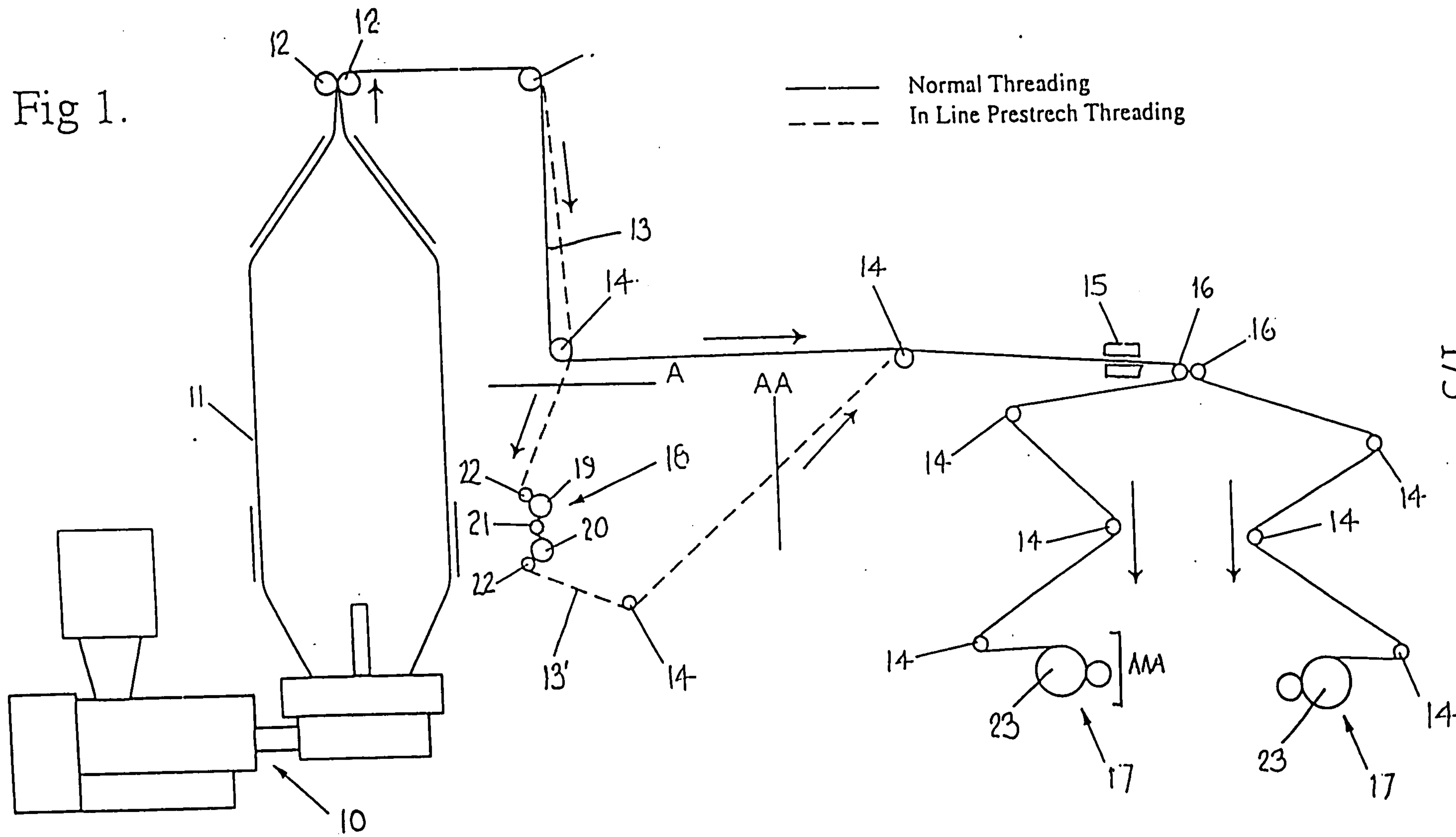
Fig 1.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12
13
14
14
15
16
16
Normal Threading
In Line Prestrech Threading
A
AA
11
22
19
18
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14
14
AA
23
17
23
17
10

Fig 2.

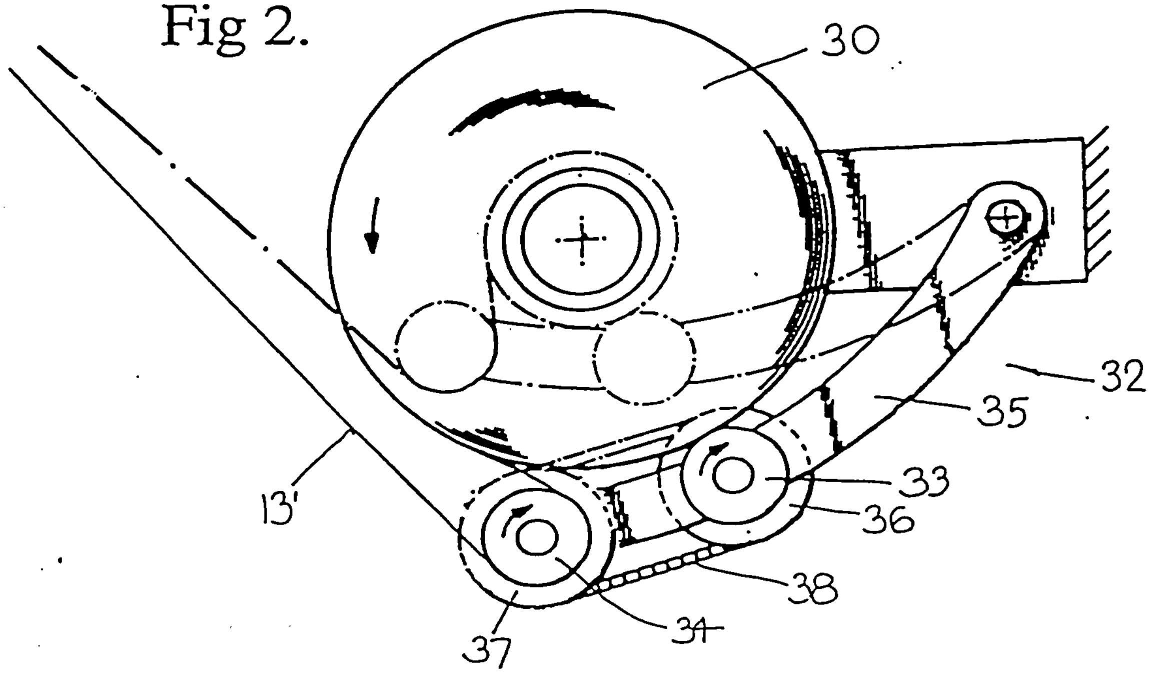

Fig 3.

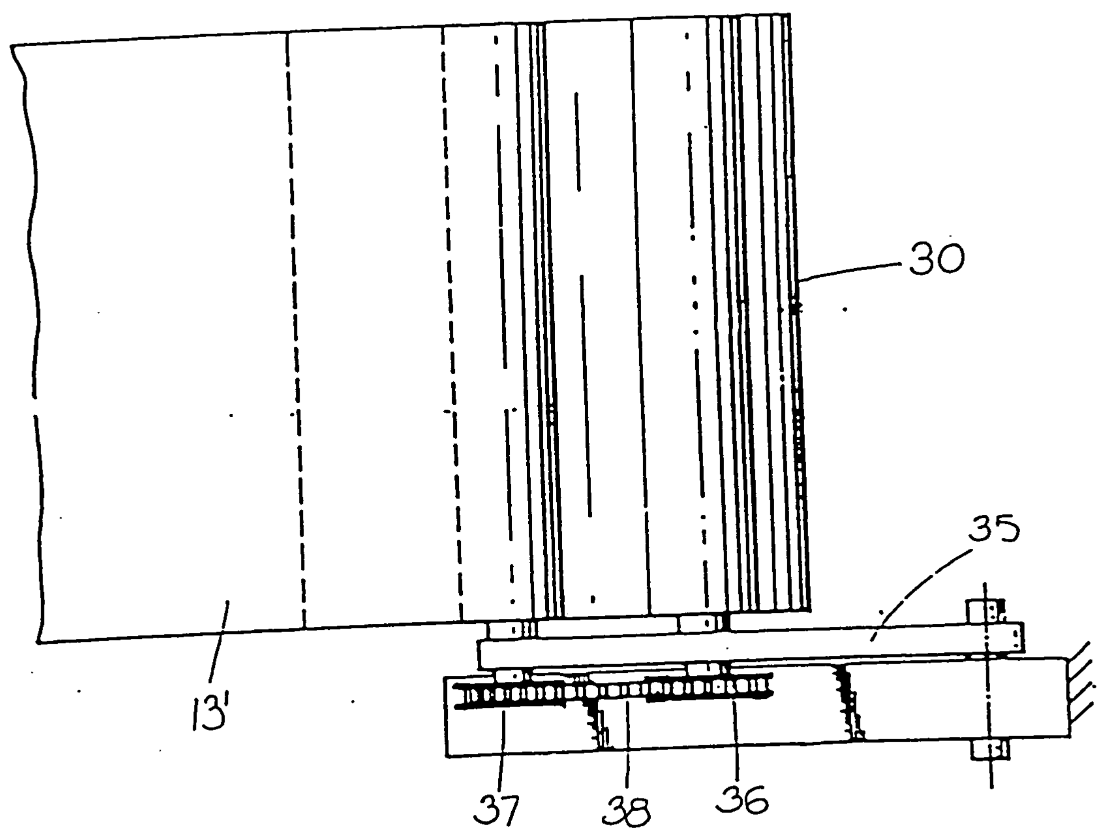

Fig.4.